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REPORT ON

WATER POLLUTION CONTROL PLANTS

REPORT 3 – PHASE I

REDUCTIONS REQUIRED FOR TOXICITY AND BIOSTIMULANTS

SEPTEMBER 1971

BROWN AND CALDWELL
CONSULTING ENGINEERS

SAN FRANCISCO

CITY AND COUNTY OF SAN FRANCISCO

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WATER POLLUTION CONTROL PLANTS

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BC BROWN AND CALDWELL
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SAN FRANCISCO

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September 1, 1971

F265A

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WATER POLLUTION CONTROL PLANTS - REPORT 3, PHASE I

In accordance with our agreement dated June 10, 1970, we are submitting Report 3, Phase I on the work covered by our agreement. Results of the work performed under Phase I are being presented in two sections, the first dealing with existing operational procedures and plant performances and the second with reductions necessary to achieve various levels of effluent quality as prescribed by the San Francisco Bay Regional Water Quality Control Board. The report submitted with this letter covers the reductions necessary to achieve various levels of effluent quality with regard to toxicity and biostimulants at the City's three water pollution control plants.

We will be happy to meet with you or your staff to discuss our report at any time you may desire.

BROWN AND CALDWELL

Frank J. Kersnar

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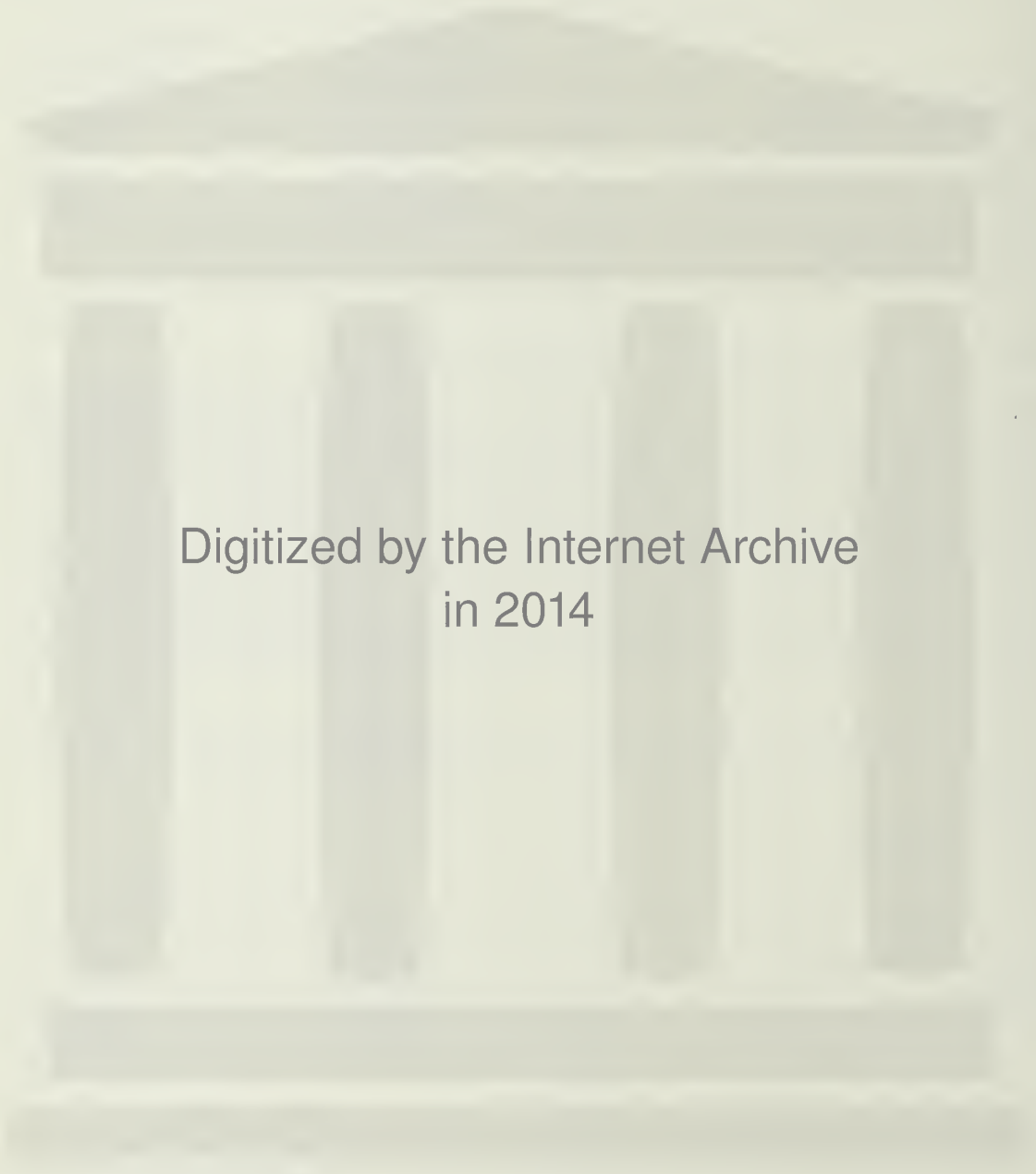

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CHAPTER 1

INTRODUCTION

By Resolution Nos. 69-44 and 70-17, the San Francisco Bay Regional Water Quality Control Board required the City and County of San Francisco to submit an engineering report on the Southeast and North Point water pollution control plants evaluating the requirements and costs of producing effluents of specified characteristics. These characteristics included receiving water clarity reduction and floatable concentration and effluent grease and settleable matter concentrations.

Although the Regional Board report requirements made no mention of receiving water nutrient, phenol, pesticide or metal concentration or effluent toxicity all were generally covered by the waste discharge requirements of Resolution No. 70-17.[1] This resolution states in part:

"WASTE DISCHARGE REQUIREMENTS - RECEIVING WATERS ...

3. Waters of the State to exceed the following limit of quality at any place within one foot of the surface at any time:

...	...
Nutrients	*to be prescribed at the earliest practicable date.*
Other substances	*any one or more substances in concentrations that impair any of the protected beneficial water uses or make aquatic life or wildlife unfit or unpalatable for consumption*

WASTE DISCHARGE REQUIREMENTS - WASTE STREAM

The waste stream discharged to waters of the State shall meet these quality limits at all times:

...

2. In any representative 24-hour composite sample:

Toxicity: the concentration of the waste itself at any place surface of the receiving waters	*10% of the 96-hour TL_m concentration of the waste as discharged, maximum*

...."

To ascertain its present compliance, its probable future requirements, the type of facilities needed, and the cost of complying with the present and probable future requirements, the City and County of San Francisco, acting through its Department of Public Works, engaged the firm of Brown and Caldwell to prepare the necessary engineering reports evaluating present plant performance and developing improvements necessary to comply with these requirements. All three of the treatment plants were included in this study.

Under the terms of an agreement for engineering services dated June 10, 1970, the required work is divided into two phases. Phase I involves a determination of existing conditions and Phase II involves an evaluation of process and operational changes. Separate reports are required for the two phases.

Objectives and Scope of Phase I Study

The primary objective of the Phase I study is to identify the quantities and qualities of the materials present in the influent, process streams and effluent of each of the city's three water pollution control plants. Under the terms of the agreement for engineering services, work to be performed included the following:

1. Review of present plant operations and processes to determine existing conditions, modes of operation, and sampling points.

2. Analysis of the influents, in-plant operation and process streams, effluents and receiving water conditions for the parameters listed in the Regional Board's resolutions.

3. Determination of probable ranges of objectives, requirements and goals for those parameters not specifically specified by the Regional Board.

4. Determination of reductions at average and peak flow conditions required to attain at least four levels of effluent and receiving water qaulity for which one or more levels shall comply with the ranges of specified and probable objectives, requirements and goals of the Regional Board.

5. Determination of the assimilative and dispersive capacity and background quality of the waters into which the Southeast water pollution control plant discharges and evaluation of the existing Southeast water pollution control plant outfall.

6. Preparation of a final report for Phase I presenting and discussion of all information developed in this phase of the investigation and including recommendations and scope for investigations to be undertaken during Phase II of the study.

The report on Phase I investigation is submitted in two sections. The first section, submitted as Report 1, Phase I, covers a review of present plant operation and performance as included in the first two items above. The second section, which this report includes, covers the determination of probable ranges of objectives, goals and requirements for those parameters not specifically specified by the Regional Board, the reductions necessary to meet the probable and specific ranges of objectives, goals and requirements and the recommendations and scope for Phase II investigation.

Abbreviations to be found in this report are defined in Appendix A. References are to be found in Appendix B. Supplemental data on plant influent and effluent metal concentrations is provided in Appendix C.

Office Work

Office work was concerned with the following principal activities:

1. A determination of the probable ranges of objectives, goals and requirements for those parameters specifically specified by the Regional Board.

2. A determination of the reductions necessary to meet the Regional Board ranges of objectives, goals and requirements.

3. A review of various chemical-physical treatment processes for the purpose of determining those processes best suited for providing the reductions required.

4. The preparation of Report 3 of Phase I.

Information and Data Made Available

In addition to the information furnished by those members of the Brown and Caldwell engineering staff who are involved in the preparation of the predesign study of submarine outfall sewers for the City, data of receiving water criteria were received from other members of the staff presently engaged in subregional study for Contra Costa County.

Progress Reports

Written reports on the progress of the study were made monthly to the Director of Public Works. Additionally, periodic meetings were held with the staff of the Sanitary Engineering Division to discuss the study progress and preliminary findings. Some information collected during the course of Phase I was also made available at the request of the Sanitary Engieering Division.

Acknowledgements

For their assistance during the study, we wish to express our appreciation to A. O. Friedland, R. T. Cockburn and W. R. Giessner and other members of the staff of the Division of Sanitary Engineering of the Bureau of Engineering and to K. Fraschina, J. H. Crafts, A. E. Bagot, W. C. Jow, L. T. Yew, R. Loucks, P. Shinn, N. Lago, A. Benas, C. Zern and D. McNulty of the Sewage Treatment Division of the Bureau of Water Pollution Control and other personnel of the Sewage Treatment Division of the Bureau of Water Pollution Control.

CHAPTER 2

REDUCTIONS NECESSARY TO MEET REGIONAL BOARD RANGES OF OBJECTIVES, GOALS AND REQUIREMENTS

Report 1 of the Phase I report covers the modes of operation and performance of the existing City and County of San Francisco water pollution control plants. Report 1 was also to include an investigation of existing receiving water conditions at the Southeast plant. Although some work was performed on this task, it could not be completed because of a rupture in an effluent line from the plant. Most of the receiving water requirements and conditions discussed in this report, therefore, have been determined from data gathered as part of the sub-regional study for Contra Costa County currently underway by Brown and Caldwell.

While toxicity requirements have already been set for two of the three plant waste discharges, receiving water quality criteria for the parameters of nutrient, phenol, pesticide and metal concentrations have only recently started to appear with some regularity in Regional Board discharge requirements. While the Porter-Cologne Water Quality Control Act[2] states as a policy that "the waters of the State shall be protected for the use and enjoyment by the people" it also declares that "the highest water quality which is reasonable should be attained considering all demands to be made on these waters and the total values involved including beneficial and detrimental, economic and social, and tangible and intangible." In this context, receiving water quality criteria developed by this study should be conservative, for in many cases they are based on discharge requirements for the waters of north San Francisco Bay where dilution volume is less and beneficial uses more critical and usually more numerous.

Ranges of Objectives, Goals and Requirements

Although the ability of the Richmond-Sunset receiving waters to accept toxic wastes and nutrient, phenol, pesticide and metal concentrations differs from the Southeast receiving waters, it has been assumed, for the purpose of this study, that all plants must meet the same discharge requirements. If the present trend in public involvement continues, it is possible that such requirements could be applied to all waste discharges, regardless of receiving water conditions.

Toxicity. Resolutions No. 69-44[3] and No. 70-17[1] of the San Francisco Bay Regional Water Quality Control Board set forth the following toxicity requirements for the City and County of San Francisco Southeast and North Point sewage treatment plant effluents:

"In any representative 24-hour composite sample:

Toxicity: the concentration of the waste itself at any place within one foot of the surface of the receiving waters	*10 percent of the 96-hour TL_m concentration of the waste as discharged, maximem."*

While these requirements seem to be acceptable at the present time for waste discharges into the central bay and ocean, it should be noted that Resolution No. 71-13[4] of the San Francisco Bay Regional Water Quality Control Board sets forth the following more stringent requirements for the City of Mill Valley, Marin County:

"4. Waste "A" as discharged to waters of the State shall meet these quality limits at all times:

....

C. In any representative set of samples:
Toxicity:
survival of test fishes in 96-hour bioassays of waste as discharged. Any determination, 10% maximum
Average of any three or more consecutive determinations made during any 21 or more days, 90% minimum"

We believe these requirements should provide the two extremes of the study range of objectives and goals for toxicity.

Nutrients. Fertilizing elements such as nitrogen and phosphorus are present in San Francisco Bay waters and support aquatic plant growth in the estuary. The concentration of these materials varies both seasonally and spatially; reflecting the growth cycles of algae and sources of land drainage or waste effluents. Water quality surveys by the University of California have demonstrated that central bay has a relatively lower nutrient content than south bay or Suisun Bay. Algal growths are likewise less dense in central bay waters where nutrients normally considered available for growth are not utilized. Algal growth in Suisun Bay was found to be five to ten times central bay levels in surveys of these waters during 1964.[5,6] The paucity of algal growth in central bay is probably more related to temperature, depth and tidal exchange considerations than nutrient content.

A nitrogen limit of 2 mg/l has been specified as a maximum for the Suisun Bay area. This limitation for total nitrogen as contained in the State Water Quality Control Policy for Tidal Waters Inland From the Golden Gate[7] was adopted as a Federal Water Quality Standard. Nutrient criteria have been suggested for other estuaries, notably, the Potomac where a phosphorus limit of 0.1 mg/l and an inorganic nitrogen range of 0.3-0.5 mg/l have been proposed. The Potomac Estuary has been troubled with excessive algal growths, particularly in the upstream reaches near Washington, D.C. Receiving water criteria may also stimulate maximum desirable algal densities. A value of 50 micrograms per liter chlorophyll has been considered a nuisance in the tidal Potomac.[8] Two recent resolutions by the San Francisco Bay Regional Water Quality Control Board (No. 71-13[4] for Mill Valley and No. 71-14[9] for Richardson Bay Sanitary District) state that where receiving waters exceed 50 micrograms per liter chlorophyll these dischargers shall not add further nutrients.

Nutrient criteria will probably be established for other municipal discharges to the San Francisco Bay system. Waste discharge requirements established in 1970 for the Central Contra Costa Sanitary District, for example, state that nutrient requirements will be prescribed at the earliest practicable date. The San Francisco Bay Regional Water Quality Control Board is considering establishment of a maximum desirable algal density criterion as recommended in the Bay Delta study with the limit probably again in terms of chlorophyll concentration. These requirements are most relevant in confined areas and in the more poorly flushed extremities of the bay system such as Richardson Bay, Suisun Bay and the south bay.

The likelihood of nutrient limitations being applied to the City of San Francisco discharges is small, since there is no rationale demanding this kind of treatment for central bay discharges unless consistency with upstream dischargers is demanded. Nutrients do not appear to be the limiting factor for algal growth in central bay. Physical factors seem to be more important in limiting growth to levels below the threshold nuisance level established for the tidal Potomac. Design of future treatment facilities for the City of San Francisco will most probably be based on criteria other than nutrients. The range of study objectives, therefore, assumes a "no nutrient removal" alternative and a 90 percent nutrient removal alternative. The latter is included only for the possibility that regulatory agencies may require consistent treatment requirements for all bay dischargers.

Phenols. Although none of the present Regional Board resolutions for San Francisco treatment plants include phenol requirements, such requirements have been established for some discharges. Most of the requirements for waste discharges in the vicinity of domestic water supply diversions in the north bay include the following:

"Waste stream shall not ...
cause the waters of the State at any point east of the western end of Chipps Island and within 2000 feet of any diversion being used for a domestic water supply to exceed the following limits of quality:

Phenols	*0.001 mg/l, maximum"*

One of the latest of the resolutions to include this requirement is Resolution No. 70-88[10] adopted November 6, 1970 for the United States Steel Corporation, Pittsburg Works.

Water Quality Criteria published by the State of California in 1963[11] indicates that a 0.001 mg/l concentration level of phenols will not interfere with the use of such waters for a domestic water supply and that concentrations to 0.2 mg/l will not interfere with fish and aqua-

tic life. Water Quality Criteria published by the Federal Water Pollution Control Administration in 1968[12] indicates that phenols can be toxic for fresh water fish and lower aquatic life in concentrations as low as 0.1 mg/l.

In 1966 the Regional Board adopted a resolution for the Sequoia Refining Corporation[13] which discharges its wastes into San Pablo Bay near Rodeo. This resolution included the following phenol requirement:

"The discharge for Waste "A" shall not cause: The waters of San Pablo Bay to exceed the following limits of quality at any place which is more than ten (10) feet from either of the two diffuser ports, nor at any other place which is within three (3) feet of the water surface:

Phenols *0.03 mg/l, maximum"*

No domestic water supply diversions are endangered by any of the San Francisco treatment plant outfalls. It is possible, however, that the goals and objectives for phenols in central bay receiving waters will fall between 0.1 mg/l and 0.03 mg/l levels.

Sulfides. No sulfide requirements have presently been set for any of the San Francisco plants. Water Quality Criteria published by the Federal Water Pollution Control Administration in 1968[12] reports that sulfide concentrations in the range of less than 1.0 mg/l to 25.0 mg/l can be lethal to fresh water fish in from 1 to 3 days. This report also suggests that appropriate application factors to 96-hour TLm values are 1/20 for sulfide. If it is assumed that bay fish are capable of producing a satisfactory 96-hour TLm for sulfide concentrations of 1.0 mg/l, the acceptable receiving water application rate after dilution should be 0.05 mg/l. This has been set as the low range goal and objective requirement.

The Regional Board, as early as 1966, placed sulfide requirements on other dischargers to the bay. The Sequoia Refining Corporation requirements[13] read as follows:

"The quality of Waste "A" as discharged shall be maintained within the following limits in any grab sample:

Sulfide, total *0.1 mg/l, average of any four or more samples collected at intervals of 3 to 7 days."*

Although this discharge is not into the central bay, it is believed that it could be applied to the central bay at some future date. For purposes of this study, therefore, a maximum concentration of 0.1 mg/l in the effluent has been assumed to be the high range of goal and objective requirements.

Pesticides. Data from the bay system gathered between 1963 and 1966 show total pesticide content of bay waters to be from 0.1 to 0.2 parts per billion. At the present time the only Regional Board receiving water requirement is general and stated as follows in most resolutions:

"The discharge shall not cause waters of the state to exceed the following limit of quality at any place within one foot of the surface at any time:

Other substances *any one of more substances in concentrations that impair any of the protected beneficial water uses or make aquatic life or wildlife unfit or unpalatable for consumption."*

It is possible that future requirements may be more specific, such as, "No individual pesticide or combination of pesticides shall reach concentrations found to be deleterious to fish or wildlife at any place." Although this is still not a specific limit, it may be as close as the Board ever gets because of the difficulty in prescribing exact figures. Water Quality Criteria published by the Federal Water Pollution Control Administration in 1968[12] indicate the following 48-hour TLm concentrations for the following chlorinated hydrocarbon pesticides:

Lindane - 0.2 parts per billion
Heptachlor-epoxide - 0.2 parts per billion
D.D.T. (incl. D.D.E. and D.D.D.) - 0.6 parts per billion
Dieldrin - 0.3 parts per billion

On the assumption that 1/100 of these levels represents a reasonable application factor, this publication recommended that the receiving water levels of these substances not be permitted to rise above 1/100 of the above levels. For the purposes of this report, these limits have been selected as the high objective and goal for pesticides. No low range point has been selected.

Metals. None of the Regional Board resolutions for the City and County of San Francisco treatment plants as of May 1971 specifically set forth receiving water or waste stream metal concentration requirements. Resolution No. 70-25[14], adopted March 26, 1970 for the San Francisco International Airport, contains the following specific requirements for its receiving waters:

"The discharge shall not:
Cause waters of the State to exceed the following limits of quality at any point within one foot of the water surface:

Chromium, hexavalent	*0.5 mg/l maximum*
Chromium, total	*1.0 mg/l maximum*
Lead	*0.05 mg/l maximum*

..., the Board considers the following to be receiving water quality goals for the points described above:

Copper	*0.05 mg/l maximum*
Zinc	*0.1 mg/l maximum"*

Probably the most complete metal requirements adopted by the Regional Board to date are those listed in Resolution No. 70-88[10] for the United States Steel Corporation, Pittsburg Works adopted November 6, 1970. The waste stream metal requirements of this resolution read as follows:

"Waste '1', '2' and '3' as discharged to waters of the State shall meet these quality limits at all times:
In any representative, 24-hour composite sample:

Aluminum, dissolved	*1.0 mg/l, maximum*
Chromium, total	*1.0 mg/l, maximum*
Copper	*0.5 mg/l, maximum*
Iron, dissolved	*7.0 mg/l, maximum any sample*
	3.0 mg/l, average of 5 consecutive samples
Lead	*0.05 mg/l, maximum*
Mercury	*0.005 mg/l, maximum*
Nickel	*5.0 mg/l, maximum*
Zinc	*1.0 mg/l, maximum"*

Whether these requirements reflect the more critical receiving waters of the north bay or a change in basic Board policy is not known. It is interesting to note that in a memorandum to Mr. Fred Dierker of the San Francisco Bay Regional Water Quality Control Board[15] dated October 13, 1970 the Regional Manager of Region 3, California State Department of Fish and Game receommended more stringent requirements for metals than where listed in Resolution No. 70-88[10]. The more stringent requirements involve iron and copper. The recommended maximum concentration in undiluted effluent for iron is 1.0 mg/l and for copper 0.05 mg/l. In addition the Department of Fish and Game recommend the maximum concentration in undiluted effluent for arsenic to be 3 mg/l and for cadmium 0.01 mg/l. It is believed that the requirements contained in the airport resolution and steel plant resolution with Department of Fish and Game revisions provide the two extremes of the study range of objectives and goals for metal concentrations.

Reductions Necessary to Meet Requirements

For the purpose of this study it is assumed that the North Point and Richmond-Sunset plants are provided with a submarine outfall with an immediate dilution in excess of 100 to 1 and that the Southeast plant existing outfall provides at least a 40 to 1 dilution. Calculations for the reductions necessary to meet all requirements reflect the existence of such dilutions.

Conclusive data are not available regarding the affect of wet weather flows on the parameters considered in this report. It is believed, however, that the dilution effect of storm water inflow will significantly decrease the concentration of every parameter in the effluent. Where large dry weather flow reductions are necessary, any treatment proposed must be capable of providing significant reductions for all flows up to and including peak wet weather flow at each plant.

North Point Water Pollution Control Plant

Resolution No. 70-17[1] of the San Francisco Bay Regional Water Quality Control Board sets forth the receiving water and waste stream waste discharge requirements and reporting requirements for the City and County of San Francisco North Point water pollution control plant. A copy of the resolution is included in Report 2, Phase I as Appendix C-1.

Toxicity. To meet the toxicity requirements of Resolution No. 70-17, the effluent of the North Point plant must be diluted at least 20 to 1. With the 100 to 1 dilution of the new sub-

marine outfall, therefore, no reduction of existing toxicity levels are required. If the toxicity levels of Richardson Bay are imposed, the receiving water requirements become waste discharge requirements and dilution cannot be considered. Under these more stringent conditions, the 28 percent average 96-hour percent survival in undiluted waste discharge (Report 1 field data) must be increased to 90 percent and the zero percent minimum 96-hour percent survival must be increased to 70 percent.

Nutrients. As indicated earlier in this chapter, no nitrogen or phosphorus effluent reductions are believed necessary to meet minimum goals and objectives. If, however, maximum goals and objectives are required both nitrogen and phosphorus concentrations will have to be reduced 90 percent. At the North Point plant this would reduce the allowable average total nitrogen concentration in composited effluent samples to approximately 3 mg/l and the average total phosphorus level to approximately 0.8 mg/l.

Phenols. Field data from Report 1 indicate that the present concentration level of phenols in the composited North Point effluent averages 0.057 mg/l with a peak level of 0.11 mg/l. The 100 to 1 dilution provided by the submarine outfall will furnish all the reduction necessary to meet the entire range of goals and objectives for central bay receiving waters for both peak and average conditions.

Sulfides. Field data from Report 1 indicate the total sulfide content of the North Point sedimentation tank effluent to be 0.1 mg/l. At this level, any dilution of more than 2 to 1 will furnish all the reduction necessary to meet the anticipated range of goals and objectives for both peak and average flows.

Pesticides. Field data from Report 1 indicate that the present average level of pesticides within the composited North Point effluent when diluted 100 to 1 falls below the receiving water concentration limits recommended by the Federal Water Pollution Control Administration in their Quality Criteria report of 1968.[12] A composite sample for one day had a Lindane concentration of 0.22 parts per billion, which could produce a receiving water concentration of 0.0022 parts per billion, slightly above the 0.002 parts per billion recommended limit. The peak flow grab sample of that same day, however, had a concentration of 0.14 parts per billion, well below the composite concentration discounting somewhat the validity of higher reading. At existing levels, it is expected that no reductions will be necessary to meet the average level requirements although a 9 percent reduction is required to meet maximum requirements for Lindane. It should be noted, however, that there was little difference in pesticide concentrations between influent and effluent. If significant reductions are required, source control external to the treatment process will probably be necessary.

Metals. Field data from Report 1 indicate that all the receiving water goals and objectives set forth in the minimum requirements will be met with the 100 to 1 dilution of the submarine outfall. Except for the iron, mercury, aluminum and lead concentrations, all effluent metal concentrations are also well below the most stringent Regional Board waste stream requirements. If the more stringent waste stream requirements are applied to the North Point plant, maximum effluent aluminum concentrations of 1.1 mg/l will have to be reduced 9 percent and maximum lead concentrations of 0.15 mg/l will have to be reduced almost 67 percent. The more stringent requirements will require the average effluent iron concentrations of 1.9 mg/l to be reduced 48 percent, the average lead concentrations od 0.11 mg/l to be reduced 55 percent and the average effluent mercury concentration of 0.019 mg/l to be reduced almost 400 percent.

Richmond-Sunset Water Pollution Control

At the present time, the Richmond-Sunset water pollution control plant of the City and County of San Francisco is operating under Resolution No. 67-2[16] of the San Francisco Bay Regional Water Quality Control Board. While this resolution does not require a report similar to that required for the North Point and Southeast plants, the City included the Richmond-Sunset plant in this study with instructions to apply similar requirements to those of the other two plants. A copy of the resolution is included in Report 2, Phase I as Appendix C-2.

Toxicity. Regional Board Resolution No. 67-2[16] contains no specific toxicity requirements. However, to meet the toxicity requirements of North Point Resolution No. 70-17[1], the effluent of the Richmond-Sunset plant, as monitored during the study sampling period, must be diluted at least 62 to 1. With the 100 to 1 dilution of the new submarine outfall, therefore, no reduction of existing toxicity levels are required. If the toxicity levels of Richardson Bay are imposed, the receiving water requirements become waste discharge requirements and dilution cannot be considered. Under these more stringent conditions, the average 96-hour percent survival in undiluted waste discharge (Report 1 field data) must be increased to 90 percent and the zero minimum 96-hour percent survival must be increased to 70 percent.

Nutrients. As indicated earlier in this chapter, no nitrogen or phosphorus effluent reductions are believed necessary to meet minimum goals and objectives. If, however, maximum goals and objectives are required both nitrogen and phosphorus concentrations will have to be reduced 90 percent. At the Richmond-Sunset plant, this would reduce the average total nitrogen concentration in composited effluent samples to approximately 3.6 mg/l and the average total phosphorus level to approximately 1.2 mg/l.

Phenols. Field data from Report 1 indicate that the present concentration level of phenols in the composited Richmond-Sunset effluent averages 0.12 mg/l with a peak level of 0.18 mg/l. The 100 to 1 dilution provided by the submarine outfall will furnish all the reduction necessary to meet the anticipated range of goals and objectives for both peak and average flows.

Sulfides. Field data from Report 1 indicate the total sulphide content of the Richmond-Sunset sedimentation tank effluent to be less than 0.1 mg/l. At this level any dilution of more than 20 to 1 will furnish all the reduction necessary to meet the anticipated range of goals and objectives for both peak and average flows.

Pesticides. Field data from Report 1 indicate that the present average level of pesticides within the composited Richmond-Sunset effluent when diluted 100 to 1 falls below the receiving water concentration limits recommended by the Quality Criteria Report of 1968 of the Federal Water Pollution Control Administration.[11] The composited effluent sample taken on August 12, 1970, had a Dieldrin concentration of 0.40 parts per billion, which, when diluted 100 to 1, could produce a receiving water concentration of 0.004 parts per billion, above the 0.002 parts per billion recommended limit. All other Dieldrin samples were considerably below this recommended limit. Similarly, the composited effluent sample taken on August 16, 1970, had a Lindane concentration of 0.27 parts per billion, which, when diluted 100 to 1, could produce a receiving water concentration of 0.0027 parts per billion, slightly above the 0.002 parts per billion recommended limit. The peak flow effluent grab sample taken that same day, however, had a concentration of 0.11 parts per billion, well below the composte concentration discounting somewhat the validity of the higher composite reading. At existing levels, it is expected that no reductions will be necessary to meet the average level requirements although a 26 percent reduction is necessary to meet the average level requirements for Dieldrin and a 25 percent reduction is necessary to meet the maximum requirements for Lindane. It should be noted, however, that there was little difference in pesticide concentrations between influent and effluent. If significant reductions are required, source control external to the treatment process will probably be necessary.

Metals. Field data from Report 1 indicate that all the receiving water goals and objectives set forth in the minimum requirements will be easily met with the 100 to 1 dilution of the submarine outfall. In fact, all the effluent metal concentrations found during the field studies, except aluminum, cadmium and mercury are well below the most stringent Regional Board waste stream requirements. If the more stringent waste requirements are applied to the Richmond-Sunset plant, the maximum influent aluminum concentration of 2.0 mg/l will have to be reduced 50 percent, the average effluent cadmium concentration of 0.03 mg/l will have to be reduced 67 percent and the average effluent mercury concentration of 0.029 mg/l will have to be reduced almost 600 percent.

Southeast Water Pollution Control

Resolution No. 69-44[3] of the San Francisco Bay Regional Water Quality Control Board sets forth the receiving water and waste stream waste discharge requirements and other requirements and conditions for the City and County of San Francisco Southeast water pollution control plant. A copy of the resolution is included in Report 2, Phase I as Appendix C-3.

Toxicity. To meet the toxicity requirements of Resolution No. 69-44[3] the effluent of the North Point plant must be diluted at least 16 to 1. With the 40 to 1 dilution of the existing submarine outfall without effluent pumping station dilution, no reduction of existing toxicity levels is required. If the toxicity levels of Richardson Bay are imposed, the receiving water requirements become waste discharge requirements and dilution cannot be considered. Under these more stringent conditions, the zero average 96-hour percent survival in undiluted waste discharge (Report 1 field data) must be increased to 90 percent and the zero minimum 96-hour percent survival must be increased to 70 percent.

Nutrients. As indicated earlier in this chapter no nitrogen or phosphorus effluent reductions are believed necessary to meet minimum goals and objectives. If, however, maximum goals and objectives are required both nitrogen and phosphorus concentrations will have to be reduced 90 percent. At the Southeast plant, this would reduce the average total nitrogen concentration in composited effluent samples to approximately 5.4 mg/l and the average total phosphorus level to approximately 1.1 mg/l.

Phenols. Field data from Report 1 indicate that the present concentration level of phenols in the composited Southeast effluent averages 0.14 mg/l with a peak level of 0.18 mg/l. The 40 to 1 dilution provided by the existing submarine outfall will furnish all the reduction necessary to meet the anticipated range of goals and objectives for both peak and average flows.

Sulfides. Field data from Report 1 indicate the total sulfide content of the Southeast sedimentation effluent to be 0.3 mg/l. At this level, any dilution of more than 6 to 1 will furnish the reduction necessary to meet the low range of goals and objectives for both peak and average flows. The high range of goals and objectives is 0.1 mg/l in the waste stream. To meet this requirement the maximum total sulfide content must be reduced by 67 percent.

Pesticides. Field data from Report 1 indicate that all present average concentration levels of pesticides within the composited Southeast effluent, except total DDT (DDT plus DDE and DDD), when diluted 40 to 1, fall below the concentration limits recommended by the Quality Criteria Report of 1968 of the Federal Water Pollution Control Administration.[12] The total DDT average concentration of 0.39 parts per billion, when diluted 40 to 1, produces a receiving water concentration of 0.01 parts per billion, above the 0.006 parts per billion recommended high limit. The composite effluent sample taken on August 26, 1970, and peak flow grab effluent sample taken in August 30, 1970, had total DDT in excess of the high limit. The maximum concentration of 0.71 parts per billion, when diluted 40 to 1, could produce a receiving water concentration of 0.018 parts per billion, three times the recommended high limit. Composite effluent samples of August 26 and 30, 1970, had maximum Landane concentrations of 0.11, which, when diluted 40 to 1, could produce a receiving water concentration of 0.0028 parts per billion. To meet the pesticide requirements at the Southeast plant, the average composite total DDT must be reduced 38 percent, the maximum total DDT must be reduced 62 percent and the maximum Lindane level must be reduced 27 percent. Other pesticide concentrations require no reductions. It should be noted, however, that there was little difference in pesticide concentrations between influent and effluent. If significant reductions are required, source control external to the treatment process will probably be necessary.

Metals. Field data from Report 1 indicate that all the receiving water goals and objectives set forth in the minimum requirements will be easily met with the 40 to 1 dilution of the existing submarine outfall. In fact, all the effluent metal concentrations found during the field studies except aluminum, total chromium,

iron, copper and mercury are well below the most stringent Regional Board waste stream requirements. If the more stringent requirements are applied to the Southeast treatment plant the maximum influent aluminum concentration of 5.7 mg/l will have to be reduced 570 percent, the maximum influent total chromium concentration of 4.6 mg/l will have to be reduced 460 percent, the average effluent iron concentration of 4.6 mg/l will have to be reduced 460 percent, the maximum influent copper concentration of 0.44 mg/l will have to be reduced 880 percent and the influent mercury concentration of 0.210 mg/l will have to be reduced 4200 percent.

CHAPTER 3

RECOMMENDATIONS AND SCOPE FOR PHASE II INVESTIGATIONS

Reduction of toxicity and biostimulants, although not required at this time by the Regional Water Quality Board, will be affected by the improved treatment processes recommended for investigation in Chapter 3 of Report 2 of Phase I. Rather than formulate an entirely new approach to achieve the necessary reductions for the toxicity and biostimulants indicated in Chapter 2, it is believed the investigations of Phase II for these parameters should be limited, at first, to a determination of the applicability of the four alternative processes previously selected. These processes include (1) improvements to existing primary treatment; (2) chemical treatment; (3) flotation treatment; and (4) biological treatment. If required reduction of any parameter cannot be achieved by the four processes as previously selected, additional treatment must be investigated.

Improvements to Existing Primary Treatment

Improvements to the existing primary treatment facilities recommended for investigation in Report 2 of Phase I will probably, with two major exceptions, have little effect on the present effluent levels of toxicity and biostimulants. The two major exceptions will be improvements involving the handling of solids thickening and conditioning for filtration and improvements which increase outfall dilution factors.

Once the solids handling facilities at the Southeast plant are improved and the thickening and elutriation tank overflows reduced to insignificant levels of flow and solids, it is assumed, based on the results of the other two plants, that the total sulfide level in the Southeast effluent will be reduced to less than the 0.1 mg/l presently found in the sedimentation tank influent. It is also assumed, after reviewing the North Point plant results, that the improved solids handling facilities at both the Richmond-Sunset and Southeast plants will result in somewhat greater removals of nitrogen, phosphorus and phenols. It is not expected, however, that these higher removals will significantly affect the reductions required for these parameters in Chapter 2. Better solids handling facilities at the Southeast plant should significantly reduce the dissolved iron concentration in the plant effluent.

The doubling of the Southeast outfall dilution factor by the constant operation of the effluent pumping station pumps will be of considerable benefit to those parameters which are related to the condition of the receiving waters. This is of special importance in meeting pesticide and phenol requirements.

Chemical Treatment

Chemical treatment can decrease the level of effluent toxicity and provide significant reductions in phosphorus. Chemical treatment increases solids removal and may also provide significant removals of certain critical metals.[17] Comparison bioassay and selective critical metal determinations should be carried out during pilot plant work to determine the validity of these assumptions.

Effluent phosphorus concentrations of 1-2 mg/l as P can be regularly achieved if chemical precipitation is accomplished in the primary or secondary portions of treatment plants.[18] Pilot plant investigations should be monitored to confirm this finding for San Francisco plants. If necessary, tertiary lime clarification followed by filtration could be used to lower the effluent concentrations to less than 0.5 mg/l.[18]

As developed in Report 2 of Phase I, chemical treatment will not provide significant nitrogen reductions. Additional physical treatment, such as air stripping of ammonia or selective ion exchange, will be required to meet the most stringent nitrogen removal requirements.

Flotation Treatment

Flotation treatment alone or with primary sedimentation is not expected to achieve reductions in toxicity and biostimulants beyond what already seems possible by improving existing primary treatment. Flotation pilot plant studies in the industrial field indicate that flotation treatment with chemicals added can produce good reductions of phosphorus.[19] These reductions seem to be about the same as those produced by chemical treatment alone and, therefore, the only apparent advantage of flotation treatment seems to be the possibility of using shorter detention times.

Biological Treatment

Biological treatment usually produces an effluent which will meet the toxicity goals and objectives. This process will not, however, provide significant removals of either nitrogen or phosphorus. Reductions of these nutrients in biological treatment is usually only slightly greater than that achieved by primary sedimentation.

Nitrogen in effluents from contact stabilization activated sludge biological plants is usually in the form of ammonia which can be toxic to bioassay fish. The biological treatment process can be designed for nitrogen removal by oxidation of ammonia nitrogen to nitrate nitrogen followed by a separate biological denitrification step to reduce nitrate nitrogen to nitrogen gas. This process, however, requires at least six times the land area presently used at the treatment plants and is not believed to be applicable to any of the City's plants.

Reduction of phosphorus by biological means is limited to cell metabolic requirements and whatever excess phosphorus (luxury uptake) cells can be encouraged to take and store. A few activated sludge plants have reported efficient phosphorus uptake, but their results cannot be duplicated at other plants by manipulation of operating conditions. At this time, therefore, the removal of phosphorus by biological synthesis and luxury uptake is not controllable.[18]

APPENDIX A

ABBREVIATIONS

APPENDIX A

ABBREVIATIONS

Abbreviations to be found in this report are listed below in order of their first use:

No., Nos.	number, numbers
%	percent
TL_m	median tolerance limit; defined as the waste concentration, expressed in percent, at which half of the test organisms die in a stated time.
mg/l	milligrams per liter
ppb	parts per billion
DDT	1, 1, 1-Trichloro-2, 2-bis (p-chlorophenyl) ethane
DDE	2, 2-Dichloro-2, 2-bis (p-chlorophenyl) ethylene
DDD	1, 1-Dichloro-2, 2-bis (p-chlorophenyl) ethane (sometimes called TDE)

APPENDIX B

REFERENCES

APPENDIX B

REFERENCES

1. California Regional Water Quality Control Board, San Francisco Bay Region, Resolution No. 70-17, "Prescribing Revised Requirements for Waste Discharge by the City and County of San Francisco from its North Point Sewage Treatment Plant and Rescinding Resolution No. 69-43", Adopted March 1970.

2. State of California, Porter-Cologne Water Quality Control Act, Revisions to the California Water Code, effective January 1, 1970.

3. California Regional Water Quality Control Board, San Francisco Bay Region, Resolution No. 69-44, "Prescribing Revised Requirements as to the Nature of Waste Discharge by the City and County of San Francisco from its Southeast Sewage Treatment Plant and Rescinding Resolutions No. 125 and 544", Adopted September 25, 1969.

4. California Regional Water Quality Control Board, San Francisco Bay Region, Order No. 71-13, "Waste Discharge Requirements for City of Mill Valley, Marin County", Adopted February 25, 1971.

5. University of California, Sanitary Engineering Research Laboratory, "A Comprehensive Study of San Francisco Bay, Volume V, Summary of Physical, Chemical, and Biological Water and Sediment Data", Berkeley, California, December 1966.

6. Bain, R. C. and McCarty, J.C., "Nutrient-Productivity Studies in San Francisco Bay", U. S. Public Health Service, July 1965.

7. State of California, State Water Quality Control Board, San Francisco Bay Regional Water Quality Control Board, "Water Quality Control Policy for Tidal Waters Inland from the Golden Gate within the San Francisco Bay Region", The Resources Agency, 1967.

8. Federal Water Pollution Control Administration, "Potomac River Water Quality-Washington D.C. Metropolitan Area", U.S. Department of the Interior, 1969.

9. California Regional Water Quality Control Board, San Francisco Bay Region, Order No. 71-14, "Waste Discharge Requirements for Richardson Bay Sanitary District, Tiburon, Marin County", Adopted February 25, 1971.

10. California Regional Water Quality Control Board, San Francisco Bay Region, Resolution 70-88, "Prescribing Requirements as to the Nature of Three Existing Waste Discharges by United States Steel Corporation, Pittsburg Works, into New York Slough and One Discharge onto Land Near Pittsburg, Contra Costa County, and Rescinding Resolution No. 594", Adopted November 1970.

11. State of California, State Water Quality Control Board, "Water Quality Criteria", Publication No. 3-A, 1963.

12. Federal Water Pollution Control Administration, "Water Quality Criteria", U.S. Department of the Interior, April 1968.

APPENDIX B (Cont'd)

References

13. State of California, Regional Water Quality Control Board, San Francisco Bay Region, Resolution No. 776, "Prescribing Requirements as to the Nature of Two Waste Discharges by Sequoia Refining Corporation, One into San Pablo Bay and One into an Evaporation Pond near Rodeo, Contra Costa County", Adopted August 1966.

14. California Regional Water Quality Control Board, San Francisco Bay Region, Resolution No. 70-25, "Prescribing Revised Requirements for Waste Discharge During an Interim Period by San Francisco International Airport Sewage Treatment Plant into the Northeast Corner of a Seaplane Harbor in San Francisco Bay, San Mateo County and Rescinding Resolution No. 69-56", Adopted March 1970.

15. Region 3, State Department of Fish and Game, Memorandum titled "Comments and Recommendations on Effluent Requirements for the Discharge of Metals to Waters of the State", October 13, 1970 to San Francisco Bay Regional Water Quality Control Board.

16. State of California, Regional Water Quality Control Board, San Francisco Bay Region, Resolution No. 67-2, "Prescribing Requirements as to the Nature of Waste Discharge by the City and County of San Francisco Richmond-Sunset Sewage Treatment Plant into the Pacific Ocean, San Francisco County and Rescinding Resolution No. 588", Adopted January 1967.

17. Nilsson, Rolf, "Removal of Metals by Chemical Treatment of Municipal Waste Water", Water Research, Pergamon Press 1971, Vol. 5, pp 51-60.

18. Federal Water Quality Administration, Advanced Waste Treatment Research Laboratory, "Current Status of Advanced Waste-Treatment Processes", U.S. Department of the Interior, July 1, 1970.

19. California Regional Water Quality Control Board, San Francisco Bay Region, Order No. 71-14, "Waste Discharge Requirements for Richardson Bay Sanitary District, Tiburon, Marin County", Adopted February 25, 1971.

APPENDIX C

SUPPLEMENTAL DATA

WATER POLLUTION CONTROL PLANT

INFLUENT AND EFFLUENT METAL CONCENTRATIONS

LABORATORY ANALYSIS

Description	No. of Sheets
North Point Plant	5
Richmond-Sunset Plant	4
Southeast Plant	3

WATER ANALYSIS REPORT

BROWN AND CALDWELL LABORATORIES

For Brown and Caldwell Job No. F318A

Report to Mr. Frank Kersnar

Copies to Mr. Warren Uhte

Date Collected 7/30/70, 7/31/70, 8/1/70, 8/2/70

Date Received 7/31/70, 8/1/70, 8/2/70, 8/3/70

Date Reported 7/29/71

Analysis No.	11541	11552	11559	11572
Source of Sample 24th Composite NPWPCP	Inf 7/30	Inf 7/31	Inf 8/01	Inf 8/02
DETERMINATION	mg/l	mg/l	mg/l	mg/l
Aluminum by AAS as (Al)	1.5	2.3	0.9	0.9
Titanium, by AAS as (Ti)	< 3	< 3	< 3	< 3
Lead by AAS as (Pb)	0.03	0.16	0.03	0.20
Mercury by flameless AAS as (Hg)	0.01	0.003	0.01	0.35

Comments:

Samples for mercury determinations processed by the acid permanganate procedure given by "Determination of Mercury by Atomic Absorption Spectrophotometric Method", Dow Chemical Co. (1970).

Remaining metals determined after digestion of samples with nitric and sulfuric acids, and hydrogen peroxide.

Analyst S. Kirby, J. Tyler

Reported by Morris Lipschutz

WATER ANALYSIS REPORT

BROWN AND CALDWELL LABORATORIES

For Brown and Caldwell Job No. F318A

Report to Mr. Frank Kersnar

Copies to Mr. Warren Uhte

Date Collected 8/3/70,8/4/70 8/5/70 8/4/70,8/5/70,

Date Received 8/6/70

Date Reported 7/29/71

Analysis No.	11579	11588	11602	
Source of Sample	24th Composite NPWPCP Inf. 8/3	Inf 8/4	Inf 8/5	
DETERMINATION	mg/l	mg/l	mg/l	
Aluminum by AAS as (Al)	1.5	0.9	1.4	
Titanium by AAS as (Ti)	< 3	< 3	< 3	
Lead by AAS as (Pb)	0.17	0.04	0.03	
Mercury by flameless AAS as (Hg)	0.003	0.06	0.01	

Comments:

Samples for mercury determinations processed by the acid permanganate procedure given by "Determination of Mercury by Atomic Absorption Spectrophotometric Method", Dow Chemical Co. (1970).

Remaining metals determined after digestion of samples with nitric and sulfuric acids, and hydrogen peroxide.

Analyst S. Kirby, J. Tyler

Reported by Morris Lipschutz

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Analysis No.	11580	11589		
Source of Sample 24th Composite NPWPCP	Eff. 8/03	Eff. 8/04		
DETERMINATION	mg/l	mg/l		
Copper by AAS as (Cu)	0.15	0.17		

Comments:

Samples prepared by digestion with nitric acid and sulfuric acids and hydrogen peroxide.

Analyst S. Kirby Reported by Morris Lipschuetz

WATER ANALYSIS REPORT

BROWN AND CALDWELL LABORATORIES

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Date Collected 7/31/70 7/30/71 8/01/71, 8/02/71 7/31/70, 8/1/70

Date Received 8/02/70, 8/03/70

Date Reported 7/29/71

Analysis No.	11540	11553	11560	11573
Source of Sample 24th Composite NPWPCF	Eff 7/30	Eff 7/31	Eff 8/01	Eff 8/02
DETERMINATION	mg/l	mg/l	mg/l	mg/l
Copper by AAS as (Cu)	0.16	0.24	0.13	0.12

Comments:

Samples prepared by digestion with nitric acid and sulfuric acids and hydrogen peroxide.

Analyst S. Kirby

Reported by Morris Lipschuetz

Morris Lipschuetz

WATER ANALYSIS REPORT

BROWN AND CALDWELL LABORATORIES

For Brown and Caldwell Job No. F318A

Report to Mr. Kersnar

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Date Collected 7/30-8/6/71 8/12-8/18/71

Date Received 7/31-8/07/71 8/13-8/18/71

Date Reported 8/23/71

Analysis No.	11665	11666	11763	11764
Source of Sample	Weekly Comp. of Daily Comp., NP Influents	Weekly Comp. of Daily Comp. NP Effluents	Weekly Comp. of Daily Comp. R-S Influents	Weekly Comp. of Daily Comp. R-S Effluents
DETERMINATION	mg/l	mg/l	mg/l	mg/l
Arsenic (As)	0.0096	0.0092	0.0076	0.0096
Beryllium by AAS (Be)	<0.1	<0.1	<0.1	<0.1
Cadmium by AAS (Cd)	<0.01	<0.01	<0.01	<0.01

Comments:

Analyst J. Tyler, S. Kirby

Reported by Morris Lipschutz

Morris Lipschutz

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Date Reported 7/29/71

Analysis No.	11713	11729	11748	
Source of Sample	24th Composite R-S WPCP	Inf. 8/14	Inf. 8/16	Inf. 8/18	
DETERMINATION	mg/l	mg/l	mg/l	
Aluminum by AAS as (Al)	0.9	2.0	0.7	
Mercury by flameless AAS as (Hg)	0.002	0.002	0.003	

Comments:

Samples for mercury determinations processed by the acid permanganate procedure given by "Determination of Mercury by Atomic Absorption Spectrophotometric Method", Dow Chemical Co. (1970).

Remaining metals determined after digestion of samples with nitric and sulfuric acids, and hydrogen peroxide.

Analyst S. Kirby, J. Tyler

Reported by Morris Lipschuetz

Morris Lipschuetz

WATER ANALYSIS REPORT

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For Brown and Caldwell Job No. F318A Date Collected 8/15-17/70

Report to Mr. Kerstner Date Received 8/18-19/70

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Analysis No.	11721	11737		
Source of Sample Richmond-Sunset Composites	24 Hr. Composite Influent 8/15/70	24 Hr. Composite Influent 8/17/70		
DETERMINATION	mg/l	mg/l		
luminum by AAS as Al	1.8	1.6		
ercury by flameless AAS as Hg	0.001	0.001		

Comments:

Analyst C. Kirby Reported by Morris Lipschutz

Morris Lipschutz

WATER ANALYSIS REPORT

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For Brown and Caldwell Job No. F318A Date Collected 8/12/70

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Copies to Mr. Uhte Date Reported 8/23/71

Analysis No.	11691			
Source of Sample Richmond-Sunset	Influent 24 Hr. Composite			
DETERMINATION	mg/l			
Aluminum by AAS, as Al	0.16			
Mercury by Flameless AAS as Hg	0.002			

Comments:

Analyst J. Tyler Reported by Morris Lipschuetz

Morris Lipschuetz

WATER ANALYSIS REPORT

BROWN AND CALDWELL LABORATORIES

For Brown and Caldwell Job No. F318A Date Collected 8/26-9/01/71

Report to Mr. Kersnar Date Received 8/27-9/02/71

Copies to Mr. Uhte Date Reported 8/23/71

Analysis No.	11959	11960		
Source of Sample	Weekly Comp. of Daily Comp. S.E.	Weekly Comp. of Daily Comp. S.E.		
DETERMINATION	Influents mg/l	Effluents mg/l		
Arsenic (As)	0.012	0.010		
Berylium by AAS (Be)	<0.1	<0.1		

Comments:

Analyst J. Tyler, S. Kirby Reported by Morris Lipschutz

Morris Lipschutz

WATER ANALYSIS REPORT

BROWN AND CALDWELL LABORATORIES

For Brown and Caldwell Job No. F318A

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Date Received 8/31/70, 9/01/70, 9/02/70

Copies to Mr. Warren Uhte

Date Reported 7/29/71

Analysis No.	11879	11907	11939	
Source of Sample	24th Composite SEWPCP Inf. 8/30	Inf. 8/31	Inf. 9/01	
DETERMINATION	mg/l	mg/l	mg/l	
Aluminum by AAS as (Al)	1.9	2.5	5.7	
Copper by AAS as (Cu)	0.15	0.29	0.44	
Chromium by AAS as (Cr)	2.4	1.6	4.6	
Zinc by AAS as (Zn)	0.4	1.0	1.1	
Mercury by flameless AAS as (Hg)	0.001	0.21	0.001	

Comments:

Samples for mercury determinations processed by the acid permanganate procedure given by "Determination of Mercury by Atomic Absorption Spectrophotometric Method", Dow Chemical Co. (1970).

Remaining metals determined after digestion of samples with nitric and sulfuric acids, and hydrogen peroxide.

Analyst S. Kirby, J. Tyler

Reported by Morris Lipschuetz

WATER ANALYSIS REPORT

BROWN AND CALDWELL LABORATORIES

For Brown and C ldwell Job No. F318A Date Collected 8/26/70,8/27/70 8/28/70,8/29/70

Report to Mr. Frank Kersnar Date Received 8/27/70,8/28/70, 8/29/70,8/30/70

Copies to Mr.Warren Uhte Date Reported 7/29/71

Analysis No.	11809	11832	11839	11868
Source of Sample 24th Composite SEWPCP	Inf. 8/26	Inf. 8/27	Inf. 8/28	Inf. 8/29
DETERMINATION	mg/l	mg/l	mg/l	mg/l
Aluminum by AAS as (Al)	1.7	1.4	1.7	1.1
Copper by AAS as (Cu)	0.24	0.28	0.21	0.16
Chromium by AAS as (Cr)	2.3	1.1	4.6	3.1
Zinc by AAS as (Zn)	0.9	0.6	1.0	0.6
Mercury by flameless AAS as (Hg)	0.002	0.0006	0.12	0.005

Comments:

Samples for mercury determinations processed by the acid permanganate procedure given by "Determination of Mercury by Atomic Absorption Spectrophotometric Method", Dow Chemical Co. (1970).

Remaining metals determined after digestion of samples with nitric and sulfuric acids, and hydrogen peroxide.

Analyst S. Kirby, J. Tyler Reported by Morris Lipschuetz Morris Lipschuetz

286-5-142